Journal of Advanced Multidisciplinary Research
Vol. 6, No. 2, 2025, pp. 114-125

ISSN: 2723-6978
http://jurnal.unissula.ac.id/index.php/JAMR
DOI: http://dx.doi.org/10.30659/JAMR.6.2.114-125

Time and Cost Performance Analysis using the Earned Value Method in the Construction Project of the Dormitory Building at Airlangga University Campus C in Surabaya

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Received:	Revised:	Accepted:	Published:
4 September 2025	7 November 2025	8 December 2025	26 December 2025

Abstract

Construction projects often face challenges in the form of delays and cost overruns due to discrepancies between plans and actual implementation. The Dormitory Building at Airlangga University Campus C in Surabaya was selected as a case study to comprehensively evaluate project performance. The purpose of this study is to evaluate time and cost performance using the Earned Value Management (EVM) method to provide an accurate picture of the deviations that occur and as a basis for project control recommendations. This study uses a descriptive quantitative approach with secondary data in the form of weekly progress reports, basic schedules, and project financial records. The analysis was conducted through the calculation of EVM indicators, which included Planned Value (PV), Earned Value (EV), Actual Cost (AC), Cost Performance Index (CPI), Schedule Performance Index (SPI), and Estimate at Completion (EAC). The results show that the project experienced delays with an average Schedule Performance Index (SPI) value of 0.92, or approximately 8% behind schedule, while the average Cost Performance Index (CPI) value of 1.05 indicates cost efficiency of 5% compared to the initial budget. The Estimated Cost at Completion (EAC) projects a completion cost of IDR 94.8 billion, which is lower than the contract value of IDR 95.6 billion. Therefore, the project is still under control in terms of cost but requires accelerated work to meet deadlines, while the application of EVM has proven to be effective as an early warning tool and a basis for decision-making in construction project management.

***Keywords**: construction project management: cost performance; earned value management; time performance*

INTRODUCTION

Construction projects often face challenges such as delays and cost overruns due to various factors such as design changes, material delays, and coordination issues. To overcome this, an objective control method such as Earned Value Management (EVM) is needed, which integrates aspects of cost, time, and scope of work quantitatively through indicators such as CPI, SPI, EAC, and VAC. This method has been proven effective in detecting deviations early on and has been widely used globally. This study takes a case study of the construction project of the Airlangga University

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Surabaya Campus C Dormitory Building worth IDR 95.6 billion with a duration of 420 calendar days, which shows a progress deviation in the form of EV that is lower than PV and AC that is higher, indicating delays and cost overruns, so that the application of EVM is considered relevant for project performance evaluation and improvement

Construction project management is one of the key factors in the success of infrastructure development. The Project Management Institute (PMI, 2021) defines project management as the application of skills, knowledge, methods, and tools to meet stakeholder needs. In the context of construction, project management includes the interrelated aspects of time, cost, quality, resources, risk, and communication, which must be systematically controlled in order to achieve project objectives (Kerzner, 2017).

Cost and time are two key indicators that determine the success of a project. Lock (2013) emphasizes that control is exercised by comparing actual results with plans and following up on any deviations. Research by Sweis et al. (2008) found that delays often occur due to weak schedule planning, while cost overruns are triggered by inaccurate initial estimates and a lack of monitoring. Therefore, quantitative methods that can provide quick and measurable performance information are necessary in construction project control.

One widely used method is Earned Value Management (EVM). EVM integrates the aspects of cost, time, and scope of work to provide a comprehensive overview of project progress (Anbari, 2003). The main indicators of this method include Planned Value (PV), Earned Value (EV), and Actual Cost (AC), which are used to calculate cost efficiency through the Cost Performance Index (CPI) and schedule accuracy through the Schedule Performance Index (SPI) (Nasution & Syahputra, 2019). The advantage of EVM lies in its ability to detect deviations early and project cost and time requirements until the project is completed (Fleming & Koppelman, 2016). The integration of EVM with project management software such as Microsoft Project and Primavera further enhances control effectiveness and supports data-driven decision making (Lestari & Nugroho, 2021).

Various studies have proven the effectiveness of EVM in construction projects. Wibowo and Ramdani (2019) showed that EVM can detect delays and cost overruns faster than conventional methods. Putra (2020) and Gunawan (2022) also reported that the application of EVM can improve coordination between stakeholders through comprehensive quantitative information. Furthermore, the integration of EVM with risk management and prediction models improves the accuracy of monitoring and replanning (Yuliani & Setiawan, 2023; Nawaz et al., 2016). These findings reinforce the urgency of using EVM as an effective project evaluation and control tool, as well as a basis for developing more adaptive models in dealing with the complexity of modern projects.

METHOD

This study uses a quantitative approach with descriptive analysis, as it utilizes numerical data related to physical progress and project costs that can be analyzed using measurable performance indicators (Sugiyono, 2017; Kerzner, 2013). The type of research is a case study focused on the construction project of the Dormitory Building at Campus C of Airlangga University, Surabaya. The case study was chosen to provide an in-depth understanding of the project implementation conditions and obstacles encountered. The data analyzed included Planned Value (PV), Earned Value (EV), and Actual Cost (AC), with performance index calculations such as Schedule Performance Index (SPI) and Cost Performance Index (CPI).

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The research was conducted at the project site located within the Airlangga University Campus C complex, Surabaya City, East Java Province. This location was chosen because it was relevant to the focus of the research and made it easier for researchers to conduct observations and collect data directly in the field (Creswell, 2014).

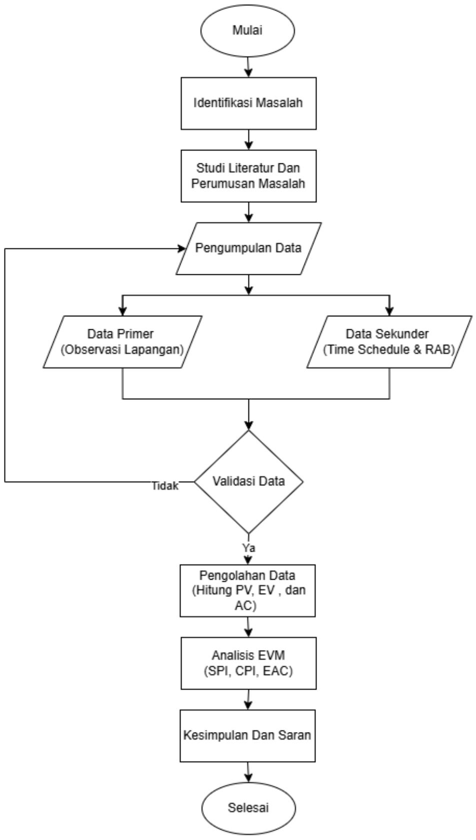

Figure 1. Research Flow Chart

Data collection was carried out through two main sources. Primary data was obtained from field observations with the assistance of relevant parties, including technical staff, construction management consultants, and contractors. This data was used to verify the conformity of the plan documents with actual conditions and to identify inhibiting factors. Secondary data was obtained from official project documents, including the Budget Plan (RAB), implementation schedule (time schedule), monthly physical progress reports, and actual cost realization reports.

The data processing stages include calculating PV, EV, and AC, as well as CV, SV, CPI, SPI, EAC, and VAC indicators using Microsoft Excel software to maintain accuracy. The analysis was conducted using quantitative descriptive methods by comparing planned and actual values to assess cost efficiency (CPI) and schedule accuracy (SPI), as well as to project project performance until completion (EAC and VAC). In addition, a Focus Group Discussion (FGD) was conducted to validate the quantitative results. FGD data were analyzed using a thematic analysis approach that included transcription, data reduction, coding, presentation, and conclusion drawing (Creswell, 2014).

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RESULTS AND DISCUSSION

Project Overview

The construction of the Airlangga University Campus C Dormitory Building in Surabaya is a multi-story building construction project intended as a student dormitory with a capacity of 227 rooms on 12 floors. This project is being carried out by PT. Nindya Karya under the supervision of management consultants PT. Amoret Mitra Consulindo and PT. Delta Buana Konsultan. The contract value is IDR 95.60 billion with a completion period of 240 calendar days, starting from January 7 to September 3, 2025. The building is designed using earthquake-resistant reinforced concrete structures in accordance with SNI standards, with the largest budget allocation for structural work (35.09%), architecture (32.26%), and mechanical-electrical systems (26.38%).

Figure 2. Construction Site

Figure 3. Construction Progress

Existing Project Implementation Performance

Time Performance

The time performance of project implementation is analyzed based on a comparison between the baseline schedule and the actual progress in the field. The data is presented in the form of a time schedule that contains the sequence of activities, duration, and implementation date of each work item. From the observations, there were several shifts in duration in structural and architectural work due to weather constraints and coordination between departments. However, most of the work is still within the tolerance range of delays that can be recovered in the finishing stage.

Cost Performance

Cost performance is analyzed by comparing the total cost budget set at the beginning of the project with actual expenditures up to the reporting period. The cost budget recapitulation shows the distribution of fund allocations for each type of work, including preparatory work, structural work, architectural work, mechanical and electrical work, and other supporting work. The analysis results show that actual expenditures are proportional to physical progress, although there are several cost items that have deviated due to changes in material specifications and variation orders.

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Table 1. Cost Budget Summary

No.	Description	Total Price (Rp)	Weight
1	Preparation works	1,529,759,822	1.78
2	Main building structural works	30,218,590,000	35.09
3	Main building architectural works	27,784,937,000	32.26
4	Main building MEP works	22,720,789,403	26.38
5	*GWT and powerhouse works*	2,148,556,025	2.249
6	Site development works	1,722,324,209	2.00
	Total amount	**86,124,957,355**	**100**
	PPn 11%	**9,473,745,309,05**	
	Total	**95,598,702,664,05**	
	Rounded	**95,598,700.00**	

The budget recapitulation in Table 1 provides a comprehensive overview of the fund allocation stipulated in the contract for the implementation of the Airlangga University Campus C Dormitory project.

Earned Value Management (EVM) Calculation

Time Calculation (SPI) is an indicator used to measure the efficiency of project implementation by comparing actual progress against the established plan. The SPI value provides an overview of whether the project is running ahead of schedule, on schedule, or behind schedule. To calculate SPI, two main parameters are required. Planned Value (PV) – The budget value allocated for work that should have been completed within a certain period according to plan. PV is calculated based on the work weight multiplied by the total project value.

PV Formula: Plan Weight (%) x BAC

Week 1 = 0.144 x 86,124,957,355 = Rp. 124,019,938.59

This calculation result is the result of the calculation in week 1. The calculations from week 2 to week 29 are presented in graph form in Figure 3.

Earned Value (EV) – the budget value for work that has actually been completed up to the measurement period based on actual physical progress.

EV formula: Realization Weight (%) x BAC

Week 1 = 0.242 x 86,124,957,355.00 = Rp. 208,422,396.80 and so on. These calculation results are the results of calculations in week 1. Calculations from week 2 to week 29 are presented in graph form in Figure 4.

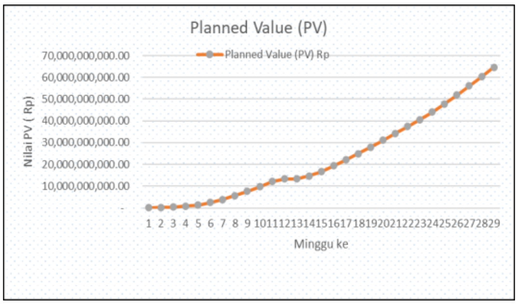

Figure 4. Planned Value (PV) Chart

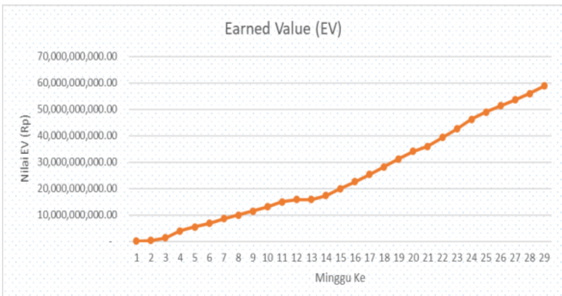

Figure 5. Earned Value (EV) Chart

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Schedule Performance Index (SPI) Recap

SPI Formula = EV/PV = 208,422,396.80 / 124,019,938.59 = 1.681

Furthermore, calculations from week 2 to week 29 are presented in graph form in Figure 5.

Interpretation: if SPI = 1, then the time is according to plan; if SPI > 1, then the time is better than planned; and if SPI < 1, then the time is less than planned (inefficient/delayed).

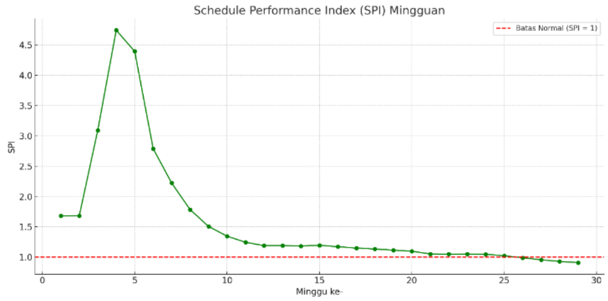

Figure 6. Performance Index Schedule (SPI) Chart

Cost Calculation (CPI)

Cost calculation in a project aims to assess the level of budget efficiency by comparing the value of work achieved with the actual costs incurred. The indicator used is the Cost Performance Index (CPI), which is the ratio between Earned Value (EV), the value of work completed, and Actual Cost (AC), the actual costs incurred during a certain period. The results of the Cost Performance Index (CPI) calculation are presented in the graph in Figure 6.

Interpretation: if CPI = 1, then the costs are within budget; if CPI > 1, then there are cost savings; and if CPI < 1, then there is cost overrun.

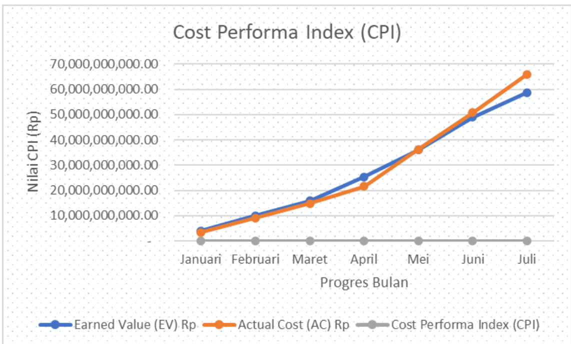

Figure 7. Cost Performance Index (CPI) Chart

It is known that from January to April, the CPI value was above 1. This indicates that the project was cost-effective, with the value of work achieved exceeding the actual costs incurred. Conversely, from May to July, the CPI value was below 1. This indicates cost overruns, as expenditures exceeded the value of work obtained.

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Performance Indicator Analysis Calculation

Project Performance Indicator Analysis aims to evaluate the efficiency of project implementation in terms of time and cost based on weekly data. These indicators are derived from the basic parameters of Earned Value Management (EVM) and are used as a tool to objectively measure the performance of construction project implementation.

1. *Schedule Variance* (SV)

   Schedule Variance measures the difference between the value of work already completed (EV) and the value of work that should have been completed according to the plan.

   SV formula = Earned Value (EV) – Planned Value (PV)

   Week 1 = 208,422,396.80 - 124,019,938.59 = Rp. 84,402,458.21 (Project ahead of schedule). These calculation results are for week 1. Calculations for weeks 2 through 29 are presented in the graph in Figure 7.

   Interpretation: If SV > 0, the project is more efficient in terms of cost/time; if SV < 0, the project is behind schedule or costly

2. *Cost Variance* (CV)

   Cost Variance shows the difference between the value of work completed (EV) and the actual costs incurred (AC).

   CV formula = Earned Value (EV) – Actual Cost (AC)

   Month 1 = 3,991,891,773.40 – 3,407,709,903.30 = Rp. 584,191,870.10 (Project costs are lower than planned). These calculation results are for January; calculations for February through July are presented in the graph in Figure 8.

   Interpretation: If CV > 0, the project is more efficient in terms of cost/time; if CV < 0, the project is behind schedule or over budget.

   It is known that from January to April, project implementation costs were lower than planned, meaning that actual costs incurred were lower than the budget allocated for the work completed. Conversely, from May to July, the CV value was negative, indicating that project costs exceeded the budget. This situation indicates cost overruns and requires further evaluation of the contributing factors.

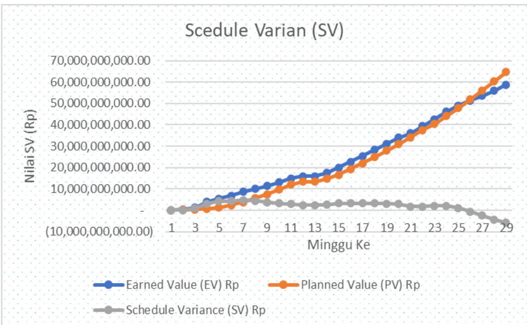

Figure 8. Schedule Variance (SV) Chart

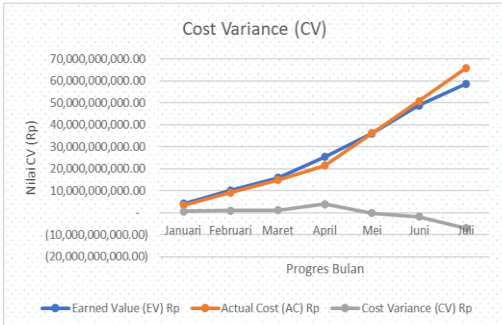

Figure 9. Cost Variance (CV) Chart

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Estimate Project Performance Projections

Project performance projections are used to predict the total final cost and the remaining costs required until the project is completed, taking into account the level of performance efficiency in the previous period. This analysis aims to provide a realistic picture of future budget requirements so that management can control costs appropriately. To calculate estimates of future performance projections, three main parameters are used, namely:

1. Estimate at Completion (EAC) – the estimated total cost of the project upon completion based on actual performance up to the measurement period.

   EAC formula = Budget at Completion (BAC) / Cost Performance Index (CPI)

   For example: January = 86,124,957,355 / 1,171 = 73,521,249,262.14

   Based on the EAC calculation from January to May, the project shows no indication of waste, which means that the total final cost projection is still within the planned budget. However, in June and July, the EAC value shows indications of inefficiency and cost waste. This suggests that if this trend continues, the total cost of completing the project could potentially exceed the initial budget.

   Interpretation: if EAC > Initial Value, then it is estimated to be over budget, and if EAC < Initial Value, then it is estimated to be within budget.

2. Estimate to Complete (ETC) – an estimate of the additional costs still required to complete the remaining project work.

   ETC formula = Estimate at Completion (EAC) / Actual Cost (AC)

   January = 73,521,249,262.14 / 3,407,709,903.30 = 70,113,539,358.84

   Based on the ETC calculation results, it is known that from January to May, the costs required to complete the remaining work were still within the budget target, with January even showing a very high level of efficiency. Conversely, in June and July, the ETC value indicated that the costs required to complete the remaining work began to increase and tended to be wasteful.

   Interpretation: if ETC > initial budget balance, there is a risk of cost overrun, and if ETC < initial budget balance, there is potential for cost underrun.

3. Variance at Completion (VAC) – the difference between the initial project budget and the estimated total cost upon completion.

   VAC formula = Budget at Completion (BAC) - Estimate at Completion (EAC)

   January = 86,124,957,355 - 73,521,249,262.14 = 12,603,708,092.86

   Based on the VAC calculation results, it is known that from January to May, the project costs were still within the budget target, and in January, the efficiency level was even very good. Conversely, in June and July, the VAC value was negative, indicating that the project began to experience overbudgeting and cost waste.

   Interpretation: if VAC > 0, the project is expected to be cost-effective, and if VAC < 0, the project is expected to exceed the budget.

Project Performance Based on Earned Value Management (EVM) Analysis

Monitoring results show deviations between plans and actuals in terms of both time and cost. In terms of time, the Schedule Performance Index (SPI) value shows a stable trend at the beginning of the project, but declines to < 1 in weeks 26 to 29, which means there are delays in work.

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Meanwhile, the cost aspect shows a Cost Performance Index (CPI) value > 1 in the January–April period, indicating cost efficiency. However, from May to July, the CPI value was < 1, which means that there was waste because the actual costs exceeded the value of the work earned.

The Schedule Variance (SV) indicator shows that the project was ahead of schedule from January to June, but fell behind in July. Meanwhile, the Cost Variance (CV) was positive from January to April (cost savings) and negative from May to July (cost overruns). These conditions indicate performance dynamics that need to be anticipated through control strategies.

Project Performance Projections

Final projections based on the Estimate at Completion (EAC) and Variance at Completion (VAC) indicators show that as of May, the project is still on track with the initial budget. However, in June–July, the EAC value increased and the VAC was negative, indicating a potential budget overrun. Interpolation results up to week 35 estimate that the final project cost could reach IDR 120.80 billion, or around 23–26% higher than the initial contract value. This condition provides an early warning that the project has the potential to experience cost overruns if corrective measures are not taken.

Validation through Stakeholder Discussions

The results of quantitative analysis using EVM were validated through Focus Group Discussions (FGD) involving Commitment Making Officials (PPK), contractors, construction management consultants, and academics. The discussions produced several important points. The PPK emphasized the need to integrate the EVM method into weekly project reports so that decision-making could be faster and more accurate. Contractors assessed that delays were mainly caused by administrative and licensing constraints. Consultants recommended standardizing the collection of physical progress data to improve the accuracy of EV calculations, while academics highlighted the importance of using EAC projections in project acceleration strategies.

Based on the results of the analysis and discussion, several recommendations can be made: (1) routine integration of EVM into the project management system, (2) improvement of field data quality to make it more valid and reliable, (3) training of human resources in the use and interpretation of EVM, (4) conducting periodic evaluations through EAC and Estimate to Complete (ETC) simulations, and (5) implementing project management software capable of automating EVM calculations.

Benchmark with Similar Projects

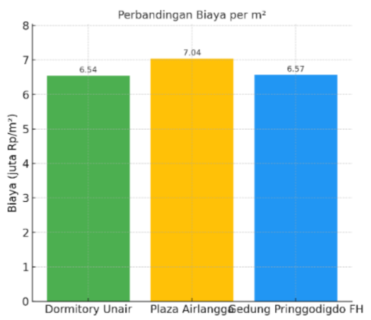

Figure 10. Cost Comparison Chart

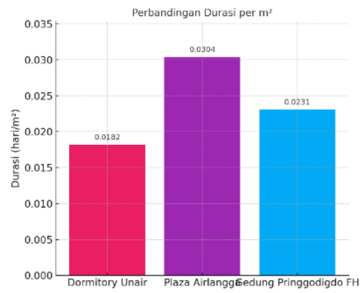

Figure 11. Duration Comparison Chart

Project benchmarking is conducted to compare the results of Earned Value Management (EVM) analysis on the project being analyzed with the performance of other projects (Unair

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Dormitory, Airlangga Plaza, Pringgodi FH Building) that have similar characteristics. The purpose of this comparison is to obtain a relative picture of time and cost efficiency, as well as to identify the project's performance position against standards or trends in projects with comparable scope, scale, and complexity.

A comparative analysis shows that the construction cost of the Unair Dormitory is Rp6.54 million/m², which is relatively reasonable and competitive compared to similar projects such as the Pringgodigdo Building of the Faculty of Law (Rp6.54 million/m²) and Airlangga Plaza (Rp7.04 million/m²). In terms of duration, this project is more efficient at 0.0182 days/m², faster than Airlangga Plaza (0.0304 days/m²) and the Pringgodigdo Building (0.0231 days/m²). This shows that despite the potential for cost overruns, the Unair Dormitory project still demonstrates superiority in terms of time productivity.

CONCLUSION

The results of the study show that the construction of the Airlangga University Campus C Dormitory Building experienced a time deviation with an average Schedule Performance Index (SPI) value of 0.92, or a delay of around eight percent from the schedule. However, in terms of project costs, it is still efficient with an average Cost Performance Index (CPI) value of 1.05, so it has the potential to generate savings of around five percent from the initial budget. The project completion estimate through the Estimate at Completion (EAC) of IDR 94.8 billion is also lower than the contract value of IDR 95.6 billion, which means that despite the delay, the project is still expected to be cost-efficient. These findings are in line with the input from the Focus Group Discussion (FGD), where both quantitative analysis with EVM and stakeholder perspectives emphasized the need to accelerate the critical path, strengthen cost monitoring, improve coordination, and improve the progress reporting system to be more real-time and sustainable.

When compared to similar projects at Airlangga University, delays were also encountered, generally due to coordination issues, minor design changes, and weather factors. However, costs remained under control with a CPI value ≥ 1 in most projects. Thus, it can be concluded that the main challenge in campus construction lies in schedule control, while cost control is already relatively well managed. The application of the EVM method has proven to be effective not only as a performance evaluation tool, but also as a benchmarking instrument to improve planning accuracy, detect deviations earlier, and strengthen decision-making in future construction projects.

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